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Review Article

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Body Schema as a Mediator between Regular, Moderate-Intensity, Holistic Exercise and a Balanced Microbiome-Gut-Brain Axis

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Abstract

The purpose of this concept-based mini-review paper was to shed light on embodied consciousness (body-mind unison) by demonstrating that the regulation of the microbiome-gut-brain axis (MGBA) can be achieved through a balanced body schema (motor habit), rather than through mechanistic processes. Expanding upon Merleau-Ponty's concept of embodiment, in the first section of the paper, the concept of body schema is explained in relation to movement and how it differs from the objectified, linear, and mechanistic ways of viewing the body and its functions. In the second section of the paper, the MGBA will be used as an example to demonstrate that its modulation depends on a stable body schema, through consistent healthy lifestyle choices like long-lasting, moderate-intensity exercise, including embodied movement programs with regulatory breathing techniques, such as Yoga and Tai Chi. An imbalanced body schema can negatively affect the MGBA and thus health. Viewing the body as a subject (body as being for itself) and not mechanistically is important to preventive, complementary, and alternative medicine, holistic health and quality of life, and the development of effective exercise programs.

Keywords: Challenging And Embodied Movement; Motor Habit; Microbiota Health; Gastrointestinal Tract; Holistic Consciousness; Merleau-Ponty; Body as Being for Itself; Complementary and Alternative Medicine; Preventive Medicine; Holistic Health

Introduction

Although several links of the bidirectional relationship among the microbiome, gut, and the brain have been studied, in this paper, the multifaceted relationship of the microbiome-gut-brain axis (MGBA) will be shown via the maintenance of a balanced body schema. Regular and properly challenging (e.g., of moderate intensity) exercise, including embodied and holistic movement programs like Yoga and Tai-Chi, is necessary for shaping a healthy body schema and thus a stable MGBA. Expanding upon Merleau-Ponty's concept of embodiment (body-mind unison) [1], the MGBA communication channels via various neurophysiological pathways are not mechanistic like the way four table legs keep a table standing. Contrary to objects in the world like a stool or a chair, the human body has consciousness that holistically derives from the body and mind via body schema (motor habit or habitual body). In the first section of the paper, the concept of body schema will be explained in relation to movement and how it differs from

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the objectified, linear, and mechanistic ways of viewing the body and its functions. In the second section of the paper, the MGBA will be used as an example to showcase that its modulation depends on a balanced body schema via consistent healthy lifestyle choices like long-lasting, moderate-intensity exercise, including embodied movement programs with regulatory breathing techniques, such as Yoga and Tai Chi. An imbalanced body schema can negatively affect the MGBA and thus health. Viewing the body as a subject with embodied consciousness (body-mind unison) and not mechanistically is important to preventive, complementary, and alternative medicine, holistic health and quality of life, and the development of effective exercise and movement programs.

How is Body Schema Different from the Objectified Body?

Based on Merleau-Ponty's Phenomenology of Perception, body schema is a pre-reflective, intersensory unity that is formed as a Gestalt via movement experiences in the world [1]. The body throws itself into meaningful movement significations (e.g., regular exercise participation) and thus embodied knowledge is gained via practice (praktognosia) [2-5]. Body schema reflects the habitual body or motor habit through which skill acquisition and understanding of the world are facilitated [1]. A balanced body schema via regular exercise is key to physical and mental health and the love of movement [2-4,6-12]. Contrary to Cartesian theorizing, the body is a living organism, the Lived Body, that acts in society: it walks, climbs, jogs, swims, dances, and expresses. It is not an object whose dimensions can be measured with perfect accuracy, like those of a table or a chair [2,3]. Nevertheless, a key question is the following: how is this approach different from the way the body is viewed and objectified in mechanistic physiology? When viewing the body as a subject, is it wrong for Kinesiologists and health-care experts to measure certain biomarkers for the detection and management of clinical conditions? How is the multi-sensorial unity in body schema different from such neurophysiological descriptions as the bidirectional relationship between afferent and efferent neurons? External sensory stimulation (vision, taste, smell, touch, pain, temperature) is sensed by the afferent neurons that send the information to the spinal cord and brain (e.g., the sauce pan is too hot), which in turn stimulate the efferent (motor) neurons to carry the signals from the brain to the peripheral nervous system (e.g., skeletal muscles and involuntary organs like lungs, heart, and the digestive system) for the proper response (e.g., release the hot pan) [13]. When describing these neuropathways, it is key to explain that their connections are not mechanistic. There is body and mind consciousness within the human organism, and thus, such bio-physiological and psychological links need to be viewed holistically based on the formation of one's body schema as a Gestalt. The relationships of the multiple neuropathways and chemical reactions in the body are not linear directions from path A to path B and vice versa; rather, the interactions are organic, holistic, and multifaceted, involving conscious, subconscious, and pre-reflective lived experiences that encompass body schema [1-3]. When a child first experiences a hot pan, they do so organically, and they know how to avoid it pre-reflectively next time they encounter a similar situation. Although it is not necessarily erroneous to measure physiological biomarkers for the diagnosis and management of clinical conditions, it is important to properly interpret those indicators by viewing the body and its functions holistically (with consciousness) and not mechanistically.

As an example, the way exercise modulates the MGBA will be shown below. Specifically, the MGBA is best modulated when physical movement is regular, properly challenging (e.g., of moderate intensity vs. prolonged high intensity), and/or embodied, emphasizing improved body schema (e.g., body awareness, control, confidence, rhythmic breathing, and expression) like in Yoga [14-16]. If the relationships in the MGBA were mechanistic, then irregular, single bouts of exercise should be enough to permanently regulate the MGBA, like when a carpenter tightens loose screws to stabilize a wobbly table leg. Reaching and maintaining homeostasis within the human body (with consciousness) is far more complex than fixing broken tables (and other objects in the world) that have no consciousness. As will be observed below, consistency in healthy lifestyle choices with emphasis on exercise is key to shaping and maintaining a balanced body schema for the health of the MGBA. Subsequently, overall health (physical, cognitive, mental) and immunity can also improve.

Consistency in Healthy Forms of Exercise is Key to the Modulation of the Microbiome-Gut-Brain Axis via Body Schema Mediation

In an attempt to holistically understand physical and mental health, recent studies have focused on the homeostasis of gut microbiota and its bidirectional connection with the brain [17,18]. The gut microbiome or Gastrointestinal Tract (GT) comprises about 100 trillion microorganisms, including bacteria, viruses, archaea, fungi, and protozoa [19], and encompasses more than 150 times the human genome [20]. Homeostasis in the gut microbiome is key to host physiology by metabolizing dietary fibers, facilitating food absorption, synthesizing vitamins, regulating the immune system, and preventing harmful bacteria and toxins from entering the intestinal barrier [17,21].

Disturbance in gut homeostasis, dysbiosis, can result from poor dietary and exercise habits as well as psychological stress. During gut microbiota imbalance, there can be an increase in harmful bacteria and a decrease in beneficial bacteria, as well as decreased diversity and abundance of gut microbes. Consequently, health challenges can arise, including metabolic, autoimmune, and cardiovascular diseases, gastrointestinal conditions, neurological disorders, and mental health problems like depression and anxiety [21-24].

The microbiome interlinks with the brain (MGBA) via various ways, such as the vagus (largest cranial) nerve, the enteric nervous systems, neurotransmitters (e.g., serotonin, dopamine, noradrenaline, and gamma-aminobutyric acid [GABA]), metabolites (e.g., short-chain fatty acids), pro- and anti-inflammatory cytokines, and the hypothalamic-pituitary-axis (HPA) [25-28].

Multimodal (e.g., aerobic and resistance training), regular, moderate-intensity exercise has shown the best effects on increased gut microbiota diversity and intestinal integrity compared with only one type of exercise. On the contrary, prolonged, high-intensity exercise results in increased pro-inflammatory bacteria, intestinal permeability ("leaky gut"), and splanchnic hypoperfusion (reduced blood flow in the GI tract), leading to increased inflammation and gastrointestinal issues [14,29-34]. Additionally, mind-body exercises with regulatory breathing like Yoga and Tai Chi improve gut motility and microbiota diversity and modulate the HPA axis by lowering cortisol levels and increasing serotonin production, leading to decreased stress and depression [14-16]. Importantly, the benefits of exercise on gut microbiota cease after returning to a sedentary lifestyle [35]. This means that when body schema is "in shape" via consistent healthy lifestyle choices like regular and holistic exercise programs, the MGBA is also in balance. The process of its regulation is not mechanistic but organic, involving embodied consciousness within one's body schema: improved body awareness, control, confidence, physical functioning and expression, and the navigation of the world [2].

Summary and Conclusion

The purpose of this concept-based mini-review paper was to shed light on embodied consciousness by demonstrating that MGBA regulation can be achieved through a balanced body schema and not mechanistically. Specifically, regular and properly challenging exercise, like moderate-intensity activities and holistic movement programs with rhythmic breathing techniques, is necessary to modulate the MGBA by shaping body schema. Participating in only occasional exercise cannot "fix" an imbalanced body schema and/or lead to the health of the MGBA because the relevant neurophysiological pathways are not explained mechanistically, like the functions of a chair, but organically through holistic consciousness (body as being for itself) while exploring the world. Certain physiological biomarkers can improve within a "mindful" (with consciousness) body (e.g., changes in breathing, thoughts, intentions, emotions) that can be achieved only with consistent healthy practices (e.g., safe forms of physical movement and proper diet) in the world.

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